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273. Proposed by A. H. HOLMES, Brunswick, Maine.

Required a purely geometrical solution of the problem, to find the contents of a solid generated by the revolution of a semi-segment of a circle about the sine of its arc.

Solution by the PROPOSER.

HBO is a quadrant whose revolution about BO as an axis generates a hemisphere. BAF is a semi-segment of radius $=BO$. Draw AM parallel to HB and MI parallel to BO . Suppose the quadrant to revolve about its axis a very small distance, the point H moving to L so as to generate $HBOLB$, M falling on N . Through NE pass a plane parallel to HBO . The semi-segment $HMI=AFB$ generates $HIELMN$; of which the part $EKLN$ =part generated by BAF .

It is obvious that the volume generated by the semi-segment BFA in an entire revolution will equal that generated by HMI minus the sum of the solids $HIKEMN$ lying about the circumference of the base of the hemisphere.

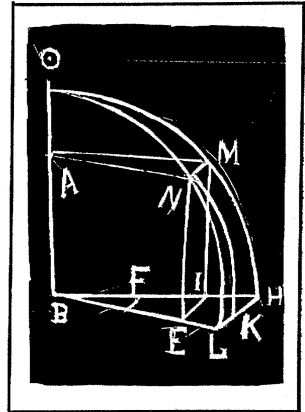
But $MNHIEK=IE \times$ area of the semi-segment and the entire sum of all these is equal to the circumference described by BI as radius into the same area. If we put $BO=r$, $BE=c$, $BA=s$, and arc $AF=a$, we obtain for the solid generated by

$BOMI$, $\frac{2\pi}{3}(sc^2 + r^3 - r^2s)$. Consequently, for the solid generated by HIM ,

$\frac{2\pi}{3}(r^2s - sc^2)$. The sum of all the solids $HKEINM$ =semi-segment $MHI \times 2\pi c$
 $=\pi(ca - r - sc^2)$. Consequently the volume sought is

$$= \frac{2\pi}{3}(r^2s - sc^2) - \pi(ca - r - sc^2) = \pi\left(\frac{sc^2}{3} + \frac{2r^2s}{3} - ca\right).$$

Putting $c^2=r^2-s^2$, this becomes $\pi(s r^2 - s^3/3 - ca r)$.



GROUP THEORY.

14. Proposed by O. E. GLENN, Springfield, Mo.

Hölder has proved* that any group (G) of order $\sum_{i=1}^n p_i$ (p_i a prime $\neq p_j$) may be generated as follows: $M^\mu = N^\nu = 1$, $N^{-1}MN = M^a$, where $\{M\}$ is the product of all the invariant subgroups of G of prime order and $\{N\}$ is any one of a set of conjugate cyclical subgroups of order ν , ($\sum_{i=1}^n p_i = \mu\nu$). Find the generating relations of G in terms of operations of prime order, and express M and N in terms of these operations, for $n=4$.

*See Burnside, *Theory of Groups*, p. 353.